



University of Technology, Sydney

# **Fuzzy Transfer Learning for Financial Early Warning System**

A Thesis Submitted for the Degree of  
Doctor of Philosophy

By

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November, 2012

## CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Candidate

A handwritten signature in black ink, appearing to read 'Viktor', is written above a horizontal line.

# DEDICATION

*To my beloved Mother, for her prayers for me.*

*To the soul of my Father, the first to teach me.*

# ACKNOWLEDGEMENTS

First, I would like to express my sincere gratitude to my PhD principal supervisor, Prof. Jie Lu, for offering me an opportunity to begin my research study three years ago. Thank you for your continuous support, encouragement, precious guidance and patience throughout my study. Thank you for your accurate critical comments and suggestions, which have strengthened this study significantly. Your strict academic attitude, generous personality and conscientious working style have influenced me deeply, and will be of great benefit to me in my future research work and life. I have learned a lot more from you than you realize. I also would like to address my sincere thanks to my co-supervisor, A/Prof. Guangquan Zhang for his knowledgeable suggestions and valuable advice, which have greatly improved the final quality of my PhD thesis.

Most of all, I would like to express my deepest appreciation to my Mother. Thank you for supporting me and always being there for me during my ups and downs. Pursuing a PhD was always a long term challenge for me and a dream of my mother's. This dream would have not been achieved without the love, great empathy and kind assistance of my mother. Very special thanks to my mother who believes in me more than I do in myself.

I would like to express my highest appreciation to my sister, Leila, for her unconditional encouragement and support throughout my study. It would have been impossible for me to complete my study without her help. She shared all my pain, sorrow and depression in the most difficult time of my research. Her optimistic view of life encourages me a lot, not only in my research but also in my life.

I would also like to thank Ms. Sue Felix for helping me to identify and correct grammar, syntax and presentation problems in my thesis. I am grateful to the School of Software in the Faculty of Engineering and Information Technology at the University of Technology, Sydney. This study was fully supported by the International Postgraduate Research Scholarship (IPRS).

Finally, I wish to express my appreciation to all my friends and the members (especially Mr. Qusai Shambour) of the Decision Systems & e-Service Intelligence (DeSI) Lab in the Centre for Quantum Computation and Intelligent Systems (QCIS) for their help, participation and valuable comments in every presentation I made during my study.

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# ABSTRACT

Financial early warning system aims to warn of the impending critical financial status of an organization. A financial early warning system is more than a classical prediction model and should provide an explanatory analysis to describe the reasons behind the failure; the explanatory ability of a system is as important as its predictive accuracy. In addition, failure prediction is intrinsically a class imbalance problem in which the number of failed cases is much less than the number of survived cases. Also, the vagueness in the value of predictors is an inevitable problem which has emerged in the uncertain environment of the finance industry. Scarcity of training data is another critical problem in finance industry; a new type of financial early warning system, which can be transferred and modified for different domains to transfer knowledge to new prediction domain, is highly desirable in practical applications because it is easy to install and cheap to setup.

To achieve the aforementioned properties, this study develops algorithms, methods and approaches in the case of bank failure prediction. First, a novel parametric adaptive inference-based fuzzy neural network approach is devised to predict financial status accurately and generate valuable knowledge for decision making. It handles the imbalance problem and the vagueness in features' value using parametric learning and rule generation algorithms. Second, a fuzzy domain adaptation method is developed to transfer knowledge from a related old problem to the problem under consideration and the labels are then predicted with a high level of accuracy. This method handles the data scarcity problem and enables the financial early warning system to be transferrable between prediction domains which are different in data distribution. Third, a fuzzy cross-domain adaptation approach is proposed to make the financial early warning system transferable from different but related domains to the current domain. This approach handles the problem in which the feature spaces of

prediction domains are different and have vague value. This approach selects the significant fuzzy predictors in the current prediction domain by transferring knowledge from the related prediction domains.

The proposed algorithms, methods and approaches are validated and benchmarked in each step of development using experiments performed on real world data. The results show that this study significantly enhances predictive accuracy at different stages of development. Finally a case study is performed to integrate and validate the proposed methods and approaches using Australian banking system data. The results demonstrate that this study successfully solves the abovementioned problems and significantly outperforms existing methods.